involved the skin and produced a V-shaped depression with a fullness beyond. It will be observed that the other lines on the hands are also noticeably similar in their main conformations.

Since identical twins are monovular, they must be absolutely identical so far as all inherited characteristics are concerned. Such differences as gradually appear are produced by differences in environment. Galton said: "Illness or accident is the only cause which is adequate to make similar twins dissimilar." However, Dupuytren's contracture has rendered these two similar rather than dissimilar, which might suggest that Dupuytren's contracture is neither a disease nor an accident, but is, rather, a variation in growth of palmar fascia, the potentiality for which is inherited. In this connection it will be remembered that most textbooks contain a short and unconvincing suggestion that Dupuytren's contracture is caused by trauma. Elderly gentlemen who carry canes with crooks on the handles are thought to bruise their palmar fasciæ and so set up fibrosis. Why it should appear in both hands is not made clear. We do not recall having observed elderly gentlemen carrying two canes as they stroll through the park.

The characteristics which identical twins possess in common are far more deep-rooted and important than mere similarity of appearance, colour of eyes, shape of nose, curly hair, or even temperament. Elemental biological qualities governing life, growth, and even death itself are also identical. Militzer[2] reports the occurrence of adenocarcinoma of the cardiac end of the stomach in identical twins of 72 years of age. Both were carpenters; the symptoms first appeared within three weeks of each other; and both were in hospital at the same time for the treatment of carcinoma. Munford and Linder,[3] report the appearance of adenocarcinoma in the outer quadrant of the left breast of an elderly woman who was one of a pair of identical twins. When her sister was sent for, she, too, was found to have adenocarcinoma in the outer quadrant of the left breast.

Such cases of identical twins showing identical carcinoma offer support for the tenets of Slye and Macklin. Further, the mere fact that such duplications can occur is sufficient reason for urging that the discovery of a disease, in which there may be even an element of heredity, in an identical twin, be regarded as justification for summoning his counterpart and examining him for the same condition.

REFERENCES

1. NEWMAN, H. H., FREEMAN, F. N. AND HOLZINGER, K. J.: Twins, University of Chicago Press, 1937, p. 35.
2. MILITZER, R. E.: Carcinoma of the stomach in identical twins, *Am. J. Cancer*, 1935, 25: 544.
3. MUNFORD, S. D. AND LINDER, H.: Carcinoma of the breast in homologous twins, *Am. J. Cancer*, 1936, 28: 393.

PHYSIOLOGICAL STUDIES IN EXPERIMENTAL DROWNING

(A PRELIMINARY REPORT)

BY F. G. BANTING, G. E. HALL, J. M. JANES, B. LEIBEL AND D. W. LOUGHEED

Department of Medical Research, Banting Institute, University of Toronto

THE need for adequate knowledge of the physiological factors involved in drowning and the appreciation and application of such factors is essential in any further advances in methods of resuscitation. The urgency of the situation is obvious, and in an endeavour to disseminate knowledge on the subject to the medical profession we are presenting this preliminary report of some of the physiological mechanisms involved in experimental drowning. We have attempted to recommend, on the basis of our incomplete experimental work, certain procedures for the treatment of drowning cases. These recommendations are, of necessity, subject to change as further experiments warrant.

Some of these recommendations have been incorporated in the recent report by Bates.[1] The value of prolonged artificial respiration has likewise been re-emphasized by Bates, Gaby and MacLachlan.[2]

In the first series of experiments on the process of drowning it was found that the condition is essentially one of asphyxia, and that there are two types of drowning.

In type I the sequence of events is as follows. There is a period of apnœa during which time there occurs an initial struggle followed by a cessation of movement and then swallowing takes place. When the stomach is distended a period of spasmodic convulsions intervenes,

followed by vomiting. This period of apnœa is replaced by an interval during which 2 to 10 gasps occur, when water may be heard entering the lungs. Reflexes then disappear and somatic activity apparently ceases.

In type II drowning the sequence of events in the apnœic stage is practically the same as in type I but is not followed by gasping. Consequently very little, if any water enters the lung and death is due to obstructive asphyxia.

The heart rate and blood pressure present terminally distinctive difference in the two types. In type I the pressure falls suddenly just before death to approximately zero; the heart rate likewise decreases suddenly, fibrillation frequently occurs, and electrocardiographic activity ceases within 1 to 2 minutes. In type II drowning the blood pressure falls more gradually, the heart rate decreases to 10 to 15 beats per minute, and, later, the ventricular complexes disappear. The auricular complexes may be present for 30 to 45 minutes after death.

Many intermediate grades of both types have been found experimentally.

The importance of obstructive asphyxia cannot be too greatly emphasized, as indicated by many succeeding experiments. When fluid is introduced through a cannula into the trachea below the cricoid cartilage relatively large quantities can be added without significant respiratory embarrassment. However, in many instances amounts as small as 2 c.c. coming in contact with the larynx are sufficient to produce apnœa by severe spasm of the glottis. Prolonged asphyxiation with death, the result of spasm of the glottis, has frequently been produced with 10 to 18 c.c. of water. In some instances no reflex closing of the glottis could be demonstrated, the water simply being aspirated into the lung, as in type I drowning.

The extent of the spasm of the glottis in drowning has been shown in another way. The trachea was severed low in the neck. An open cannula was inserted into the distal end of the trachea thus allowing normal free respiration to continue. Another cannula was inserted into the proximal portion of the trachea, thus providing a free passage from the mouth to the open end of the cannula. By the use of a special mask water was poured into the mouth. Almost immediately spasm of the glottis occurred and no water came through the open proximal cannula. When the reflex spasm was prevented by previously spraying the larynx with cocaine the water drained through the larynx and through the proximal cannula. Again, when the larynx was sprayed or painted with cocaine after the spasm had occurred relief of the spasm was promptly obtained and the water once more passed through the larynx.

The slow heart rate which is noticed in most of the drowning experiments appears to be due to vagal influences. Consequently, atropinization following initial drowning appears to have definite beneficial effects, the heart increasing in rate within a few minutes. The atropine, too, prevented the accumulation of much œdema fluid in the lungs—a condition which was almost always present in drownings when atropine was not used.

Analysis of arterial blood during drowning shows that the oxygen decreases very rapidly to 2-3 vol. per cent at the time of the spasmodic convulsions and remains relatively constant at this level. Blood CO_2, after an initial rise during struggling, also decreases, resulting in inadequate stimulation of the respiratory centre. This, in combination with the spasm of the glottis, produces prolonged and severe asphyxia.

In experimental drowning artificial respiration through a tracheal catheter increases the number of recoveries. When amyl nitrite is gently blown into the catheter in combination with the artificial respiration a still larger number of recoveries is obtained. This measure increases both coronary and pulmonary circulation. Artificial respiration, using 20 per cent CO_2 and 80 per cent O_2 gives additional stimulus to the respiratory centre. As soon as normal breathing has started the gas mixture is changed to 5 per cent CO_2 and 95 per cent O_2.

The autopsy findings in experimental drowning show the lungs to be hæmorrhagic and œdematous. In both types of drowning œdema fluid and froth is found throughout the bronchial tree and exudes freely from the cut surface of the lung. Much more fluid and froth is found in type I than in type II. A variable amount of water is found in the lungs, depending upon the number of gasps. If dyed water is used, and the lungs examined immediately after death, irregularly stained areas, extending out to the periphery of the lung, are seen adjacent to tissue which appears unstained and relatively normal. Microscopically, the tissue resembles that found in acute pulmonary œdema.

Invariably the right heart is found to be greatly distended, the left heart contracted and

empty. The stomach is constantly found distended with water, since the swallowing reflexes are active during the time the glottis is closed. This distension causes considerable cardiac embarrassment but produces no serious lasting consequences.

From the experimental results obtained so far the following resuscitation measures are recommended. As soon as the patient is recovered from the water he should be held up so that water may drain from the stomach and lungs and then placed in the prone position. All foreign matter should be removed from the mouth and larynx, gum, false teeth, weeds, etc., the tongue pulled forward with a handkerchief or tongue forceps and the Schafer method of artificial respiration immediately started. (See Bates, Gaby and MacLachlan[2]). It is of vital importance that there should be a free passage of air in and out of the chest. Therefore, if this cannot be detected the larynx should be swabbed with 10 per cent cocaine or a catheter passed into the trachea with the aid of a laryngoscope, if available, or even by the direct vision method. If artificial respiration is carried out without an adequate air passage the pressure will cause rupture of alveoli, adding to the already heavy odds against the patient. If a tracheal catheter has been inserted initial suction of this tube will remove much of the foam filling the trachea and bronchi. Insufflation of 20 per cent CO_2 and 80 per cent O_2 has been found to be most effective, delivered at 3 litres per minute into the trachea. If intubation has not been done this gas mixture may be delivered through a nasal catheter into the pharynx. In type II drowning, where little if any water is aspirated and death may occur through asphyxiation, it is suggested that a pearl of amyl nitrite blown in through a tracheal catheter before insufflation is begun is the most effective measure yet found. Adrenaline has been found to be indicated, in doses of 40 minims of 1:1,000, to assist the heart's action. Atropine, gr. 1/50-1/25, injected intravenously, decreases the foam and œdema in the lungs as well as increasing the heart rate and removing inhibitory influences of the parasympathetic nervous system. It is highly important to keep the patient warm and to massage the extremities towards the heart.

Artificial respiration must be carried out immediately at the scene of the accident, and if the patient is moved by ambulance to the hospital, artificial respiration must be continued throughout. Transference then to a respirator unit may be made.

Even though the heart beats are not heard by means of a stethoscope and the pulse cannot be detected, *artificial respiration must be continued until rigor mortis sets in.* In many of our experiments the cardiac complexes have been detected electrocardiographically for as long as 25 minutes after the heart sounds could not be heard with a stethoscope. Many such observations have been made in human cases. Among others, Birchard[3] has taken electrocardiograms during and after death in a great many cases, and approximately normal electrocardiograms were obtained for upwards of one-half hour after all signs of somatic activity had ceased. Consequently, and this cannot be too strongly emphasized, the stethoscope is probably a poor instrument with which to determine whether or not a person is beyond the point of resuscitation. Prompt, adequate, and prolonged artificial respiration is the only treatment for drowned, asphyxiated or electric-shocked persons. In the case of drowning the additional procedures as outlined above are recommended, for the reasons stated.

REFERENCES

1. BATES, G.: Artificial respiration, *Bull. Acad. Med.*, Toronto, 1938, 11: 288.
2. BATES, G., GABY, R. E. AND MACLACHLAN, W.: The need for prolonged artificial respiration in drowning, asphyxiation and electric shock, *Canad. M. Ass. J.*, 1938, 39: 120.
3. BIRCHARD, C. C.: Personal communication.

AGE AND FERTILITY.—O. Kolb has reviewed 59,117 gynæcological and obstetrical cases from the point of view of fertility and age. The fertile period stretched between the ages of 12 and 49, with an optimum at 23. The fertility of the group between the ages of 12 and 15 was only slight, but it rapidly increased from the age of 16. The gradual decrease of fertility after the age of 23, apart from natural causes, seemed to be due to diseases resulting from previous childbearing; acquired sterility as a result of criminal abortion; the increase of venereal diseases; the increased use of contraceptives; and the decrease in sexual intercourse with increasing age. Since the war the difference between the habits of the urban and rural population has been levelled out. The rural population, too, have become acquainted with contraceptives and criminal abortion. Conditions have probably changed in those countries where a premium is put on fertility. On the whole the survey showed that fertility in a civilized country is influenced by a variety of factors, not the least of which are economic. A true picture of the relationship between age and fertility could only be obtained in a primitive community, uninfluenced by modern civilization and free of material cares.—*Münch. med Wschr.*, April 8, 1938, p. 502. Abs. in *Brit. M. J.*